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ARTIFICIAL INTELLIGENCE: APPLICATION IN PHARMACY

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ABSTRACT

AI technology has been identified for analysing as well as interpreting some important fields of pharmacy like drug discovery, dosage form designing, poly-pharmacology, and hospital pharmacy. Given the growing importance of AI, to create a comprehensive report it is necessary which helps every practicing pharmacist understand the biggest breakthroughs which are assisted by the deployment of this field. AI has come a long way in healthcare, having played significant roles in data and information storage and management – such as patient medical histories, medicine stocks, sale records, and so on; automated machines; software and computer applications like diagnostic tools such as MRI radiation technology, CT diagnosis and many more have all been created to aid and simplify healthcare measures. Inarguably, AI has revolutionized healthcare to be more effective and efficient and the pharmacy sector is not left out. This article aims to address the potential of AI in revolutionizing pharmacy practice. It explores the current state of AI applications in pharmacy, identify the gaps and challenges and suggest possible strategies for integrating AI tools into everyday practice, thereby propelling the pharmacy sector into a new era of personalized and efficient healthcare.

KEYWORDS: Artificial intelligence, pharmacy, pharmacist, Hospital Pharmacy.

INTRODUCTION

The first application of a computer in a pharmacy presumably dates back to the 1980s and since then, computers have been utilized in everything from data collection, retail pharmacy management, clinical research, drug storage, pharmacy education, clinical pharmacy and lots more and with the emergence of artificial intelligence, there is no telling just how much the

Pharmacy sector will evolve in the long run. There have been several expert systems developed in medicine to assist physicians with medical diagnosis.[1,2]

Recently, AI technology becomes a very fundamental part of the industry for useful applications in many technical and research fields. Reflecting on the past 25 years, pharmacy has done a great job of addressing the growing demand for prescriptions, even when faced with pharmacist shortages, growing operating costs, and lower reimbursements. Pharmacy has also done a great job of leveraging enabling technology automation to improve workflow efficiency and lower operating costs while promoting safety, accuracy, and efficiency in every pharmacy setting. Automated dispensing gives pharmacists more time to engage with a greater volume of patients while also enhancing their health outcomes.[3]

AI, defined as the ability of machines to simulate intelligent human behaviour, has numerous applications in healthcare including data analysis, disease prediction, and personalized treatment recommendations.[4,5] This can significantly alter several aspects of patient care. For pharmacists in particular, this revolutionary technology could automate repetitive tasks, decrease human errors, and provide precision-driven patient-centric care.[6] Google's Deep Mind crafted an AI system that adeptly analysed eye scans from thousands of patients, predicting conditions like age-related macular degeneration and other predisposing factors. Pharmacists might leverage such systems to anticipate adverse drug reactions in patients vulnerable to specific conditions.[7]

AI-powered tools process electronic prescriptions to pinpoint potential errors like incorrect dosages, drug interactions, or contraindications using patient history. By analysing the context and semantics, AI identifies discrepancies that might be missed in manual medication order reviews. Deep learning algorithms integrate into automated dispensing systems, ensuring accurate medication selection and dispensing. Additionally, these algorithms forecast medication restocking needs based on past usage and current inventory, optimizing supply chains. AI chat bots and virtual assistants, using natural language processing, furnish patients with medication details, side-effect advice, and answers to prescription-related queries. These AI resources can decode patient questions, even those in layman's terms, offering lucid answers that bolster patient understanding and adherence.

Advantages

- Artificial intelligence presents the pharmaceutical industry with the opportunity to solve problems previously unsolvable with simple data analysis.[7]
- AI is able to perform specific tasks and more accurately thereby reducing cost while increasing productivity.
- AI offers valuable insights that will dramatically improve the outcomes of clinical trials.
- Deep learning about Market dynamic, Customer behaviour and their interplay.
- Matching unmet customer needs with enhanced and differentiated value offerings - both Tangible and Intangible.
- It improves the performance of antivirus detection systems and promotes production of new artificial intelligence algorithm.
- It also helps in terms of the industry's selection of patient for clinical trials and enables companies to identify any issues with compounds much earlier when it comes to efficacy and safety.
- AI would have a low error rate compared to Humans, if coded properly. They would have incredible precision, Accuracy and speed.
- Robotic radio surgery and other types of surgery in the future, can achieve precision that Humans can't.
- AI is reinventing drug discovery by using deep learning and natural language processing to understand and analyse vast quantities of bioscience information.[7,8]

Disadvantages

- AI mainly lacks in Human touch, since it doesn't have capacity to think, it can only function according to programs.
- It has the efficiency to corrupt younger generation.
- Can be changed foremost to mass scale destruction.
- If robots, starts to switch humans in all fields, it will finally lead to unemployment.
- Can cost a lot of money and time to build, repair and rebuild.
- Machines can easily lead to destruction, input in the wrong hands.
- As seen partially with smart phones and other technologies already humans are dependent on AI and lose their mental capacities.
- AI as robots can super cede humans, enslaving us.

Application of Artificial Intelligence

AI in Hospital Pharmacy

There are several applications of AI in hospital-based health care systems.[9,10] in organizing dosage forms for individualized patients and selecting suitable or available administration routes or treatment policies.

- **Maintenance of Medical Records**

Maintenance of the medical records of patients is a complicated task. The collection, storage normalizing, and tracing of data are made easy by implementing the AI system. Google Deep Mind health project[11] (Developed by Google) assists to excavate the medical records in a short period. Hence, this project is a useful one for better and faster health care. The Moor fields Eye hospital NHS is assisted by this project for the improvement of eye treatment.

- **Treatment Plan Designing**

The designing of effective treatment plans is possible with the help of AI technology. When any critical condition of a patient arises and the selection of a suitable treatment plan becomes difficult, then the AI system is necessary to control the situation. All the previous data and reports, clinical expertise, etc., are considered in the designing of the treatment plan as suggested by this technology. IBM Watson for Oncology[12], the software as a service, is a cognitive computing decision support system that analyzes patient data against thousands of historical cases and insights gleaned from working thousands of hours with Memorial Sloan Kettering Cancer Centre physicians and provides treatment options to help oncology clinicians make informed decisions. These treatment options are supported by literature curate by Memorial Sloan Kettering, and over 300 medical journals and 200 textbooks, resulting in almost 15 million pages of text.[12]

- **Health Support and Medication Assistance**

In recent years, the uses of AI technology are recognized as efficient in health support services and also, for medication assistance. Molly[14] (a start-up-designed virtual nurse) receives a pleasant voice along with a cordial face. Its aim of it is for helping patients to guide the treatment of patients as well as support them with their chronic conditions during doctor's visits. Ai Cure[15] is an app existing in a Smartphone webcam, which monitors patients and assists them to control their conditions. This app is useful to patients with severe medication situations and for patients who participate in clinical trials.

- **Accuracy of Medicine**

AI shows a good impact on genomics and genetic development. Deep Genomics[16], an AI system is useful for observing patterns in the genetic information and medical records to identify the mutations and linkages to diseases. This system informs doctors about the events happening within a cell when DNA is altered by genetic variation. An algorithm is designed by the father of the human genome project, Craig Venter[17] that gives information on patients' physical characteristics based on their DNA. "Human Longevity" AI technology is useful to identify the exact location of cancer and vascular diseases in their early stage.

- **Drug Creation**

The development or creation of pharmaceuticals takes more than a decade and consumes billions of rupees. "Atomwise"[18], an AI technology that uses supercomputers, is useful to find out the therapies from the database of molecular structure. It hurled a virtual search program for safe and effective therapy for the Ebola virus with the existing drugs. The technology identified two drugs that caused Ebola infection. This analysis was completed within one day compared to months to years with manual analysis. A Biopharma company in Boston developed big data for the management of patients. It reserves data to find the reasons why some patients survive diseases. They used patients' biological data and AI technology to find out the difference between healthy and disease-friendly atmospheric conditions. It helps in the discovery and design of drugs, healthcare, and problem-solving applications.

- **AI Helps People in the Health Care System**

The "open AI ecosystem"[19] was one of the top 10 promising technologies in 2016. It is useful to collect and compare the data from social awareness algorithms. In the healthcare system, vast information is recorded which includes patient medical history and treatment data from childhood to that age. This enormous data can be analysed by the ecosystems and gives suggestions about the lifestyle and habits of the patient.

- **Adverse Drug Reactions**

Al also plays a pivotal role in quality improvement. by identifying patterns in medication errors and adverse drug reactions. AI can offer insights into potential systemic issues, thus informing quality improvement strategies. For example, Google's AI has demonstrated its ability to predict adverse event in hospital and formulate preventative measures, leading to enhanced patient safety and overall care quality.[20]

For example, in 2018, Google unveiled a significant advancement in cardiovascular disease (CVD) studies. Their researchers, harnessing machine learning techniques, crafted an AI model capable of estimating an individual's heart disease risk by examining the retina.[21]

- **Chemical Substructure Representation(CASTER):**

AI tool that can conduct an extensive assessment of hidden features depicts drugs or pairs of drugs based on these common structures. It then uses deep learning techniques to create a universal representation of these drugs. This can help in anticipating possible drug- drug interaction and adverse drug reaction, enhancing the safety and efficacy of pharmaceutical treatments.[22]

- **AI Predictive Analytics Capabilities**

AI have the potential to streamline patient care by predicting health trajectories based on current treatment plans and patient health histories. Tools like Google Deep mind have shown the ability to accurately forecast hospital readmission rates for heart failure patients, providing pharmacists with a more precise tool for customizing care strategies.[23]

- **In Patient Education**

AI plays a vital role, translating sophisticated medical advice into more digestible and compre hensible formats. Interactive chatbots, such as Buoy Health[24], offer personalized advice abo ut medication usage, diet changes, lifestyle modifications, and treatment plans, fostering incre ased understanding and compliance.

- **In Consultations**

AI is ability to swiftly analyse new research finding, guidelines and patient specific information enables pharmacists, equipped with tools path AI to rapidly generate evidence based treatment recommendations, thereby strengthening collaborative healthcare processes.[25]

AI algorithms have proven themselves to be invaluable tools in therapeutic drug monitoring, continuously analyzing patient data, including biomarkers, to assess the efficacy and safety of medication therapies, platforms like Dosis Personalized Dosing use real time patient data to suggest optimal medication dosages based on individual responses for better therapeutic outcomes.[26]

AI in Community Pharmacies

AI promises to revolutionize community pharmacy practice, extending its impact beyond pharmacists' primary responsibilities.

- **Firstly**, AI enhances supply chain management. AI algorithms can analyse a vast amount of data, including past sales, seasonality, local health trends, promotional activities, and even external factors like weather patterns or disease outbreaks, to predict demand for various medications. This helps pharmacies maintain an optimal inventory, minimizing stock outs (when high-demand items run out) and overstock (where items remain unsold, potentially expiring before being sold). Furthermore, AI automates the reordering processes to maintain optimal inventory levels. By monitoring stock levels in real-time and automatically generating purchase orders to replenish stocks when levels fall below certain thresholds, this technology can save staff time and help ensure essential medications are always readily available for purchase. AI tools can also evaluate suppliers based on factors like reliability, cost, delivery speed, and product quality.[27]

- **Secondly**, AI can improve Automated Dispensing Systems (ADSs). AI can significantly increase accuracy and precision in dispensing, learn from past errors, and employ machine learning algorithms for continuous system optimization.[28] AI's capability to swiftly sort and label medications, anticipate maintenance needs, and tailor dispensing according to each patient's specifications will not only maximize operational efficiency but also foster personalized patient care. By integrating automated dispensing with other aspects of pharmacy management, such as inventory control and electronic health records, AI can further streamline medication processes from prescription generation to billing. AI's ability to cross-reference dispensed medication against patients' health records provides an extra safe guard, promptly alerting pharmacists of potential drug interactions or patient allergies, thus greatly enhancing patient safety.

- **Thirdly**, AI assists in advancing public health monitoring. AI systems can analyze large-scale health data sets to detect trends in disease out breaks, drug usage patterns, and other public health issues that may require a response by pharmacists or public health organizations. For instance, AI could detect an upsurge in reported flu symptoms from certain regions through data parsing[29], subsequently notifying pharmacists in those regions about potential outbreaks. This will prompt them to stockpile antiviral medications, flu shots, and

over-the-counter remedies in anticipation of increased demand. Furthermore, AI can aid pharmacists in tackling health equity challenges by analysing data such as zip codes, demographics, and medical histories. By correlating zip codes with socioeconomic indicators and health outcomes, AI can pinpoint areas with pronounced health disparities, offer tailored patient recommendations, and provide insights for specific policy actions. Such understanding can pave the way for more strategic and effective healthcare initiatives. For example, AI might pinpoint areas with high adult diabetes rates, which can inform the creation of educational programs, provision of complimentary medications, or enhanced access to care for affected individuals.

- **Fourthly**, AI tools can boost pharmacies' profitability. By analysing data such as past sales and local health trends, AI algorithms can predict medication demand[27]. This ensures optimal inventory management, minimizing stock outs or over stocks that could negatively impact profits. Moreover, operational efficiency improvements, a direct result of AI integration, contribute significantly to profitability. Automating tasks like dispensing medication and managing inventory allows pharmacy staff to focus on higher-value services like patient counselling and care. This not only enhances service quality but may also open new revenue streams. AI tools such as chat bots or automated reminders can increase patient engagement. For instance, an AI Chatbot could provide personalized medication advice, promoting better adherence among patients. This can improve patient health outcomes and foster loyalty, as customers are more likely to return when offered personalized and attentive service. In terms of cost savings, AI can reduce dispensing errors that lead to costly reimbursements or reputational damage, patient harm, and prevent equipment breakdowns, thus saving on unexpected repair costs. AI also facilitates data-driven decision-making. For example, AI could analyse sales data to identify high-margin products, allowing a pharmacy to concentrate its marketing efforts on these items for increased sales. AI can identify trends suggesting new revenue opportunities, such as an unmet need in local communities for certain health products or services. Efficient staffing through AI not only enhances patient satisfaction but directly links to the profitability of pharmacists. Optimizing staffing levels means pharmacists can attend to a greater number of patients without compromising on the quality of service, thereby increasing revenue. Moreover, satisfied customers often lead to repeat business and word-of-mouth referrals, further boosting profitability. Reducing overheads by avoiding overstaffing, combined with the increased revenue from efficient service, enhances the overall financial health of the pharmacy.

AI General Overview

The term AI (also known as machine intelligence) is very commonly confused and used interchangeably with robotics and automation. While robotics is simply the creation of machines that can carry out difficult repetitive tasks, AI refers to the exhibition of human-like behaviours or intelligence by any computer or machine.[30] Such intellectual and cognitive processes include learning, reasoning, problem-solving, perception, and language. The form of AI currently in use today is referred to as narrow AI or weak AI because it is only designed to perform narrow tasks like internet search, facial and voice recognition, controlling and driving cars, and so on. However, the long-term goal of the AI community is to have machines that can autonomously outperform humans at all cognitive tasks. The AI that involves creating machines that can perform all human cognitive tasks will be the general AI or Strong AI (ADI).[31]

CONCLUSION

AI holds incredible promise to transform both hospital and community pharmacy settings. AI promises to revolutionize pharmacy practice by streamlining administrative processes, improving decision-making based on data-driven insights, and individualizing patient care. Predicting medication demand, improving dispensing accuracy, and automating tasks such as inventory management are just some of the many ways this technology will significantly enhance operational efficiency. Meanwhile, its role in patient engagement and education fosters loyalty and enhances health outcomes. AI's predictive analytics and ability to interpret large amounts of data can inform preventative care strategies, improve quality control measures, and uncover revenue opportunities. Thus, AI plays a vital role in shaping the future of pharmacy, promising increased job satisfaction among pharmacists, as well as more profitable and efficient pharmacy practices.

AI can enable clinical pharmacists to concentrate their efforts on delivering superior, patientc entric care rather than on administrative duties, leading to improved patient outcoms and incr eased job satisfaction and professional fulfillment for pharmacists.

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